Space Weather Technical Forecast

Issued on Wednesday, 13 September 2023 at 13:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-flares likely (R1-R2 radio blackouts). Slight Chance of G1 Minor storms throughout given likely coronal hole fast wind influence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with only C-class flares observed. The largest event was a C5.6 at 12/2200 UTC from AR3423. There are currently seven sunspot regions on the visible disc. AR3423 remains the largest region on the disc, but has shown little growth and remains magnetically simple. AR3425 remains a modestly sized but elongated region comprised of a number of smaller spots. AR3429 in the eastern disc continues to display some magnetic complexity, but only minor growth within its intermediate spots, with the region to its southeast maintained as a NEW and currently un-numbered mature solo spot. AR3430 has shown some significant growth within its intermediate portion. AR3431 maintains its more complicated north-south magnetic configuration, but with some waxing and waning of its spots. AR3433 (Hsx/Alpha) in the northeast is a simple spot and stable. No Earth directed CMEs observed during the past 24hrs.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 by ACE/DSCOVR were slightly elevated at first, around 400-420km/s, due to arrival of a CME, before falling erratically back to generally slow levels from around 12/1430 UTC. Solar winds have since steadily increased back up to slightly elevated, near 430-440km/s, probably due to the arrival of HSS from CH44/+. Density followed a similar pattern, starting the period well above the average, approximately 71ppcc following the arrival of the CME, before erratically dropping back to average or below average values. The Interplanetary Magnetic Field (IMF), Bt, started the period at moderate to strong levels, with the arrival of the CME, peaking at around 20nT at approximately 12/1400UTC before slowly declining to moderate levels as Earth entered the magnetic cloud associated with the CME, although it look likes the influence of the CME has waned. The north-south component, Bz, became moderately negative (southward) with the arrival of the CME and strongly negative upon entering the likely magnetic cloud, seeing a peak of -19nT before slowly rising to more weakly negative levels. Phi angle has been mostly positive (away from the Sun) following the the arrival of the CME.

Geomagnetic activity was at G1/minor storm levels at the start of the period, with a Kp5 observed 1200-1500 UTC, with a Kp6 (G2 moderate storm) observed in the 1500-1800 UTC interval. Thereafter, mostly Unsettled to Active (Kp3-4), but has recently returned to Quiet levels (Kp0-2) as the influence of the CME wanes.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background. GOES16 high energy (greater than 2MeV) electron flux was at background to moderate levels. The associated 24-hour fluence was well below the Active threshold, with 2.77e6 integrated pfu observed at 13/0000UTC.

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Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low activity is expected, but with further M-class flares likely, and a slight chance of an isolated X-flare.

Solar Wind / Geomagnetic Activity: There is one Earth-directed CME in the forecast. This is from the filament eruption that occurred around 11/1400 UTC that gave a CME off towards the south. This has been analysed and may give Earth a weak glancing blow possibly later on Day 3 (15 Sep).

Recent unexpected CME influence appears to have now waned with a return to a more ambient regime expected at least in the short term. Coronal hole fast wind enhancement expected into the forecast period however, firstly most likely from CH44/+ in the northwest disc, though ENLIL model output continues to signal CH46/- in the southwest as the dominate feature. Some influence from either or both these features expected through Day 1 into Day 2 (13-14 Sep) with an increase in solar winds to slightly elevated to elevated levels (450-550km/s) likely. Into Day 3 or more likely Day 4 (15-16 Sep) some connection to CH47/-, currently near centre disc, is likely. This features was perhaps the source of some strong solar winds (around 600km/s) on the last solar rotation, with a chance that winds may reach these levels by the end of the period.
This creates a complex and low confidence forecast, with a variety of potential coronal hole interactions, and little assistance from ENLIL modelling. Overall, largely Unsettled to Active (Kp3-4) geomagnetic activity is forecast, with a continuing slight chance of G1/Minor Storm intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at background levels, with a very slight chance of an enhancement should any larger flares occur. High energy (greater than 2 MeV) electron flux may increase to Moderate to High levels initially, but is expected to return to background levels into the period. Overall, the 24hr fluence is expected to remain below the Active threshold, but with a slight chance of rising above early in the period.

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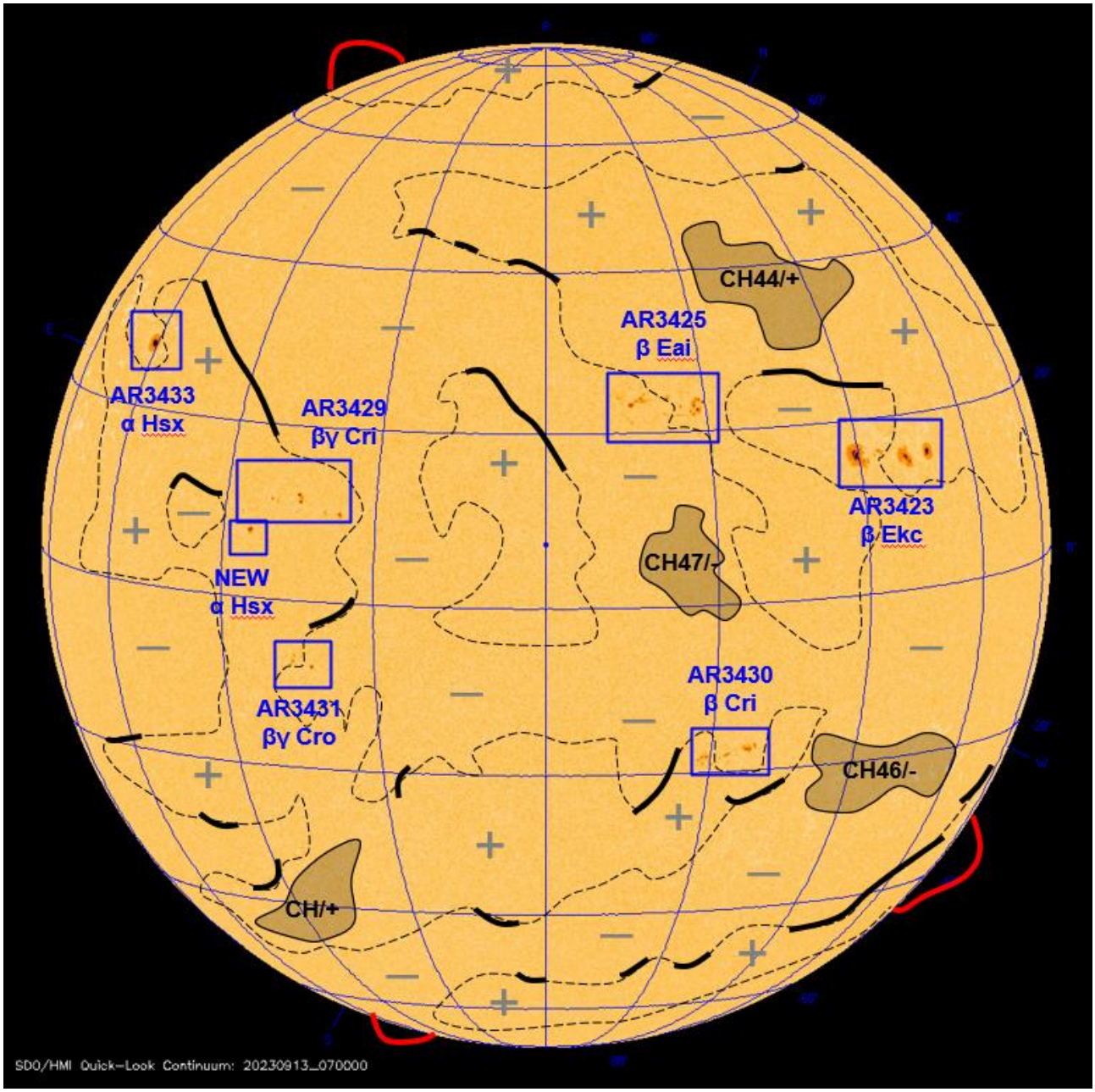
Figure 1. Solar Analysis Valid 13/0700 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one Earth-directed CME in the forecast, due to a filament eruption in the south-centre disc around 11/1400 UTC. This gave a CME off the southwest disc, which appeared slow and relatively faint in imagery. Analysis has shown that this may give Earth a weak glancing blow possibly later on Day 3 (15 Sep), with little impact expected.

Recent unexpected CME influence appears to be waning with a return to a more ambient regime expected at least in the short term. Coronal hole fast wind enhancement expected into the forecast period however, firstly most likely from CH44/+ in the northwest disk, though ENLIL model output continues to signal CH46/- in the southwest as the dominate feature. Some influence from either or both these features expected through Day 1 into Day 2 (13-14 Sep) with an increase in winds to slightly elevated to elevated levels (450-550km/s) likely. Into Day 3 or more likely Day 4 (15-16 Sep) some connection to CH47/-, currently near centre disc, is likely. This feature was perhaps the source of some strong solar winds (around 600km/s) on the last solar rotation, with a chance that winds may reach these levels by the end of the period.
This creates a complex and low confidence forecast, with a variety of potential coronal hole interactions, and little assistance from ENLIL modelling. Overall, largely Unsettled to Active (Kp3-4) geomagnetic activity is forecast, with a continuing slight chance of G1/Minor Storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	20	20	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
12/0002	Partial	Filament eruption	South-centre disc	450km/s	15/0600+/-09hrs	Limited impact expected

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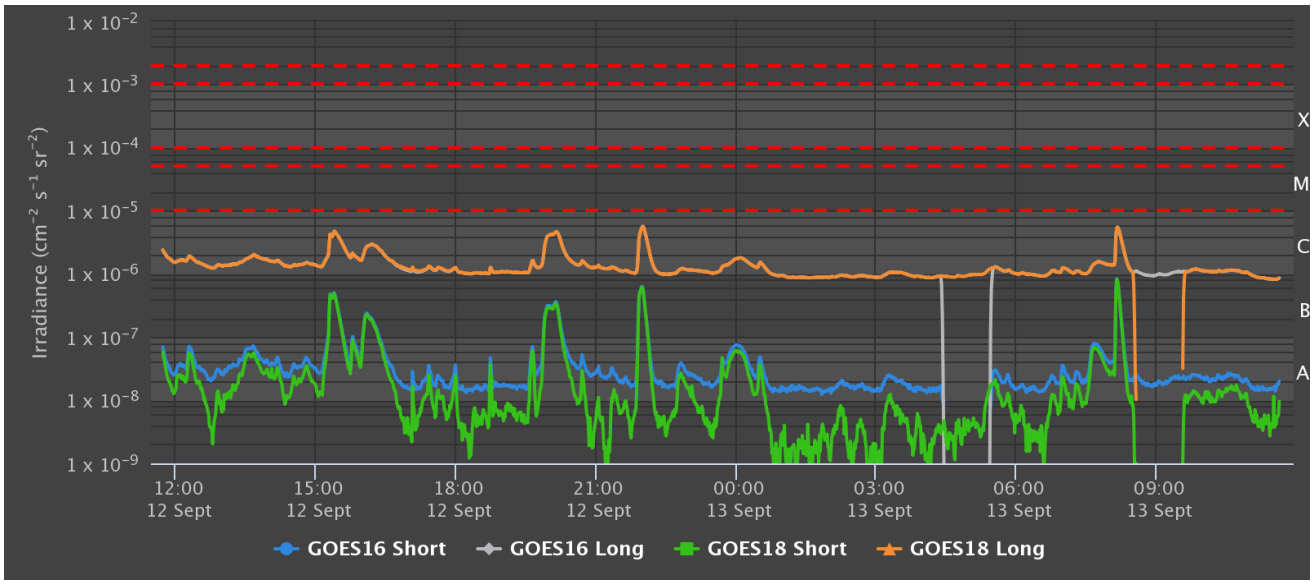
Radio Blackouts - X-Ray Flares:
Generally Low activity is expected to continue with further isolated M-flares likely and a slight chance of isolated X-flares.

There are currently seven active regions visible on the disc. AR3423 remains the largest spot on the disc and provides the bulk of the flare risk, but has shown little growth or development and remains magnetically stable. AR3425 remains a modestly sized but elongated region comprised of a number of smaller spots. AR3429 in the eastern disc continues to display some magnetic complexity but only minor growth within its intermediate spots, with the region to its southeast maintained as a NEW and currently un-numbered mature solo spot. AR3430 has continued to show some significant growth within its intermediate portion since previous analysis. AR3431 maintains its more complicated north-south magnetic configuration, but with some waxing and waning of its spots. AR3433 in the northeast is a simple spot and stable.

No significant sunspot departures expected during the period with far-side sounding data suggesting the potential for further regions to rotate on into days 3/4 (15/16 Sep) therefore current flare risk maintained throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: GOES X-Ray flares



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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels. There remains a very slight chance of flux levels rising in response to any significant flaring, particularly as AR3423 and AR3425 continue to move across the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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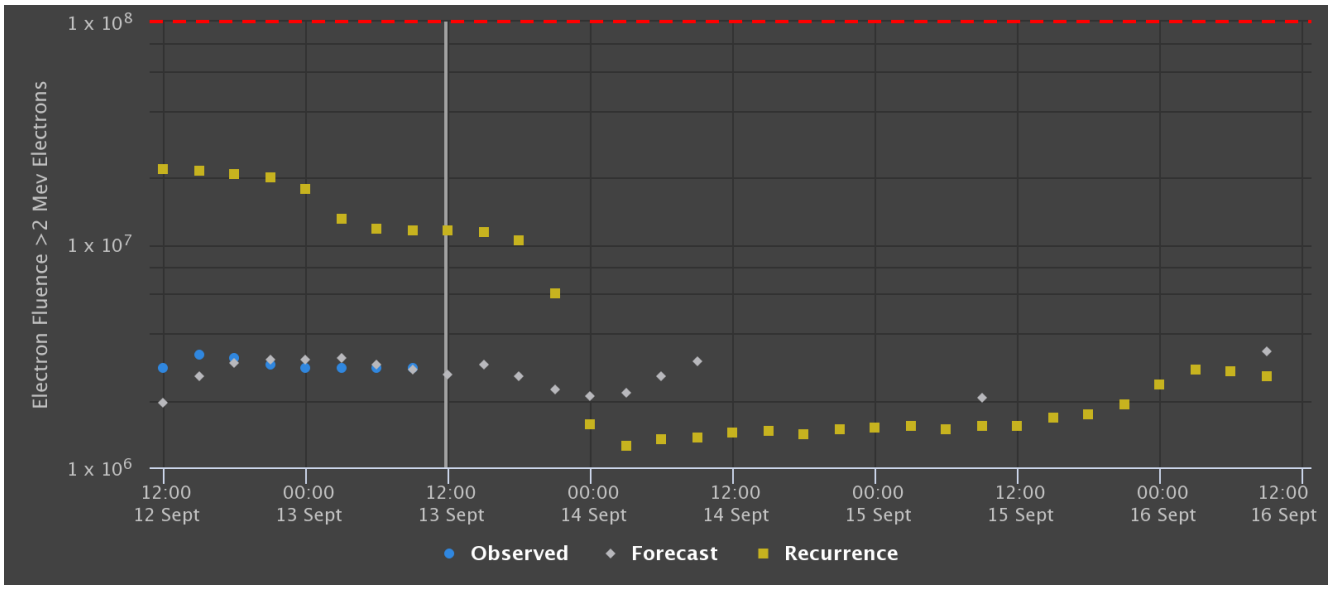
High Energy Electrons Event (≥ 2MeV):
High energy (greater than 2 MeV) electron flux observed by GOES-16 is expected to remain generally at background to moderate levels on Day 1 (13 Sep), which may rise to High levels at diurnal peak, with the recent unexpected CME likely to have increased the flux through the Van Allen belts. However this rise is low confidence, with the potential for any coronal hole fast wind arrival to disrupt the belts and lead to a drop out in observed flux which may only slowly recover later in the period.

The associated 24-hour fluence will most likely remain below the Active (1e8 integrated pfu) threshold throughout the period. MOSWOC REFM is considered to be giving generally good guidance.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	5	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: MOSWOC REFM electron fluence



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